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(54) ENERGY ABSORBING AND SIZING MEANS FOR HELMETS

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No. OF CLAIMS 13

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This invention which is a division of Canadian Patent Application Serial No. 032,931 relates to an improved helmet construction. The construction particularly comprises a mechanism adapted to be employed for receiving impact forces and for dissipating the forces to thereby materially reduce the adverse affects of the impact. In addition, the construction includes a sizing means which permits adaptation of the same helmet to a veriety of individuals and which cooperates in an ideal fashion with the energy absorbing means.

A wide variety of helmet structures have been designed for absorbing energy since there are many circumstances where individuals are susceptible to impact forces which could result in serious head injuries. In certain instances, the forces arise when the head strikes a more or less stationary object such as a wall or an automobile dashboard. In other instances, the forces arise due to impact which results when another object moves into contact with the individual. This may occur in contact sports such as football, or the impact forces could result when workmen are struck by falling objects.

In addition to energy absorbing means, a proper fit is also of critical importance in helmet construction. Provision is made for fitting by providing a head cradle, usually composed of a plurality of straps, along with some means for adjusting the straps. This is, however, somewhat unsatisfactory since completely accurate adjustments are difficult to make, and since the adjustments cannot be made while the helmet is on the head.

Since an improper fit can result in serious injury, it has been necessary for helmet manufacturers to make available a complete range of sizes of helmets. This leads to additional costs both from the standpoint of manufacturing and due to the fact that users of the helmets must secure large inventories in order to accommodate different individuals and to permit immediate replacement.

The present invention therefore provides a protective helmet construction adapted to absorb energy when subjected to impact, the improvement comprising the positioning of a number of compartments within the interior surface of the helmet, these compartments or sizing means contain a compressible fluid. A valve is provided in communication with the compartments for

intorducing and removing fluid to effect a change in the size of the compartment to allow the helmet to be warn by different individuals. Energy absorbing means are also provided having energy absorbing capabilities completely independent of the compartments and having exposed surfaces for contact with the head of the wearers when impact occurs. The compartments are located at spaced intervals over substantially the entire interior surface of the helmet and at least some of the additional energy absorbing means are located within the spaces defined between the compartments.

For the purposes of illustration, but not of limitation, specific embodiments are hereinafter described with reference to the accompanying drawings in which:

Figure 1 is a vertical, sectional view of a helmet construction provided with energy absorbing and sizing means characterized by the features of this invention;

Figure 2 is a vertical, sectional view of the helmet construction taken at right angles to the section of Figure 1;

Figure 3 is an enlarged fragmentary, sectional view illustrating the interior of a sizing element utilized in the construction;

Figure 4 is a perspective view of an energy absorbing element utilized in the construction;

Figure 5 is a perspective view illustrating an assembly of sizing compartments mounted on a common backing;

Figure 6 is a perspective view of an additional set of sizing compartments mounted on a common backing;

Figure 7 is a vertical, sectional view of a helmet construction particularly illustrating an alternative form of the invention wherein a helmet liner serves as a common backing for sizing means and energy absorbing means;

Figure 8 is an enlarged fragmentary, sectional view illustrating the preferred means of mounting a valve in association with a sizing compartment;

Figure 9 is an enlarged, fragmentary sectional view illustrating one form of fastener means for securing a liner to the helmet shell;

Figure 10 is an enlarged fragmentary sectional view illustrating an alternative form of fastening means for the liner;

Figure 11 is a cross-sectional view illustrating an alternative energy absorbing means characterized by the features of this invention;

Figure 12 is a detail cross-sectional view illustrating the arrangement of Figure 11 during operation;

Figure 13 is a cross-sectional view of an additional energy absorbing means; and,

Figure 14 is a diagrammatic illustration of the operating function of the members utilized in the helmet construction.

The helmet construction of this invention includes means adapted to absorb energy upon being subjected to impact. The invention provides for the use of first and second chambers which are flexible in nature in the sense that the interiors of the chambers are adapted to increase and reduce in size in response to the application and removal of impact forces.

A passage means is provided for interconnecting the respective chambers, and a substantially non-compressible fluid is included in the first chamber. When an impact force is applied, the fluid is adapted to be transferred from the first chamber to the second chamber through the passage means. The work involved in moving the fluid comprises a direct measure of the amount of energy absorbed. By providing an appropriate design which fits the location of the energy absorbing means in the helmet, the energy absorption capabilities will be such that injury or damage can be eliminated or reduced to a desirable minimu

The sizing means of this invention generally consist of a plurality of air compartments situated over the interior surface of the helmet shell. Valve means accessible from the exterior of the shell are provided for inflating the compartments whereby the helmet can be fit while in place on an individual's head. Additional energy absorbing means are preferably included within the compartments to provide a back-up in the event of especially high impact or in the event of failure of the primary energy absorbing means.

In a preferred form of the invention, the combination of the energy

absorbing and sizing means is placed on a liner which fits within the helmet shell. With this combination, assembly of the helmet can be accomplished in an extremely efficient manner. Fastening means for the liner and air valves are designed so that additional safety features are provided.

Figures 1 and 2 illustrate a helmet 10 provided with the energy absorbing and sizing means. The energy absorbing means are in the form of elements 12 including first and second chambers 14 and 16. The sizing means include a first set 18 for engaging the back of the neck, a second set 20 encircling an intermediate area of the head, a third set 22 for protecting an upper portion of the head and a crown piece 24.

In the arrangement of Figures 1 through 5, backing sheets 25 are provided for the sizing means. These backing sheets are individually attached to the helmet shell. The helmet shell is preferably formed of a relatively rigid material such as hard plastic, metal, or the like, and therefore a firm foundation is provided for the sizing means and energy absorbing means.

Each of the energy absorbing means carries non-compressible fluid, the major portion of which is present in the larger chambers 14. Each chamber 14 communicates with a chamber 16 through constricted passage 26. Accordingly, when force is applied to the energy absorbing means, fluid is adapted to be transferred from the chamber 14 to the chamber 16.

The energy absorbing means 12 are formed of a flexible material which can be sealed to form fluid-tight chambers, for example by gluing or heat sealing. Such materials provide the desired flexibility while also having characteristics which simplify manufacturing. In the energy absorbing elements illustrated, the material is heat sealed at 28 for purposes of forming a relatively narrow passage 26. The size of the passage will determine the amount of force required to permit transfer from a first chamber to a second chamber.

The material is also heat sealed along the line 30 to restrict the size of the chamber 16, and to thereby normally urge the fluid out of the chamber 16 into the chamber 14. Accordingly, when an impact force is removed, the energy absorbing elements will resume their normal configuration. ~~As ex-~~

As will be understood, independent means could be provided for normally compressing the chamber 16, for example, resilient bands overlying the chamber 16. It is essential to the operation of the construction, however, that the fluid be preferentially included within one chamber for transfer to the other chamber upon the application of force. Substantially all of the fluid should, therefore, be in the chamber 14 with only a minimum amount of fluid, if any, being present in the chamber 16 until a force is applied.

The construction illustrated in Figures 11 and 12 comprises a single housing 86 defining a first chamber 88 and a second chamber 90. The passages 92 and 94 interconnect the respective chambers. A first flap valve 97 permits fluid in the chamber 88 to pass into the chamber 90 while the flap valve 98 provides for reverse movement.

A suitable resilient means may be associated with the arrangement of Figure 11 for compressing the housing 86 in the area of the chamber 90 as suggested by the dotted lines. These compressing means will, therefore, resist entry of fluid in the chamber 90 while operating to urge return of the fluid through the passge 94.

The arrangement shown in Figures 11 and 12 differs primarily from the energy absorbing means 12 because of the ability of the flap valve 97 to provide for substantial changes in the size of the passage communicating the first and second chambers. Thus, in the case of the passage 26, only a relatively small increase in the diameter of the passage will occur even when high impact takes place. This increase in diameter occurs because of the resilient character of the material forming the absorbing means 12.

It will be appreciated that the features of the absorbing means 12 and 86 could be combined whereby a single passage means, having the expansion characteristics, will be provided. For example, the passage means 100 shown in Figure 14 comprises a conically shaped tubular member having a side wall of varying thickness. The opening 101 interconnects the chambers 102 and 104 thereby providing a normally open passage for movement of fluids back and forth between the chambers. The material forming the passage is flexible so

that the opening 101, being in the thin wall area, will expand by an amount depending on the size of the impact force. This is particularly important in the case of high impact, since otherwise the resistance of the chamber 102 might approach the resistance of a solid.

The energy absorbing members are located at strategic points over the interior wall of the construction. Obviously, the location of the energy absorbing means will be such that protection against energy will be provided irrespective of the direction of impact.

The sizing means of this invention each comprise a compartment 32, and these compartments are located in spaced apart relationship over the interior surface of the helmet. The location of the compartments is selected so that upon inflation of the compartments, the helmet shell will be evenly spaced apart as much as possible with respect to the head of the wearer.

The sizing compartments can be manufactured by locating a flexible material on backing sheet 25 and then sealing off the compartment, for example, by heat sealing or gluing. In the embodiment illustrated, the material is heat sealed to the backing sheet around all edges of each compartment with the exception of small passages 36 which interconnect the respective compartments. This arrangement is best illustrated in Figures 5 and 6.

A valve 38 may be associated with each compartment or set of compartments. Referring to the set 18, it will be noted that a valve is associated with the intermediate compartment, and due to the interconnecting passages 36, all of the compartments 32 can be filled with air simultaneously. In the case of the set of compartments 20, a single valve could also be employed; however, two or more valves could be positioned at intervals around the helmet shell to provide for simultaneous filling of groups of the compartments.

A strip 53 of leather is preferably provided over the compartments 32 located at the front of the helmet for positioning against the forehead. This strip of material serves as a sweatband, and it is preferably adhesively applied to permit easy removal and replacement. The use of Velcro (trade mark) as the means for attaching the band is particularly contemplated.

The sizing means 24 provided at the crown of the helmet is illustrated in the form of a bellows so as to provide a relatively large amount of

variation, however, this configuration for the crown piece is not required.

In fitting a helmet on the head of an individual, the crown portion is preferably inflated first to provide a comfortable position of the helmet, for example from the standpoint of vision. The set 20 of the compartments 32 can then be inflated to provide substantially uniform spaces between the helmet wall and the front, back and sides of the head. With reference to the set 20, separate valves may be provided for achieving "front to back" fitting before "side to side" fitting.

The compartments 32 at 18 and 22 can then be inflated in that order, without disturbing the position already established. The chambers 48 are then inflated last to provide a snug fit for the helmet, again without disturbing the position established by the initial inflation. It will be appreciated that the order of inflation described represents a convenient and efficient arrangement but that other inflating sequences are clearly available.

Each of the compartments preferably includes an energy absorbing element in its interior. These elements comprise a first layer 50 formed of standard resilient material, such as expanded vinyl, used for the padding of athletic equipment. The other layer 51 is preferably a crushable material capable of absorbing energy, for example, expanded polystyrene beads of "Styrafoam." (trade mark)

Figure 13 schematically illustrates the manner in which the various elements within the construction cooperate. The sizing means 32 absorb the energy resulting from impacts of lower magnitude. In the case of a football helmet, these sizing means may absorb all the energy as much as 60 percent of the time.

When greater forces are encountered, the absorbing means 12 come into play; these absorbing means will probably be used about 30 percent of the time when utilized in football helmets. The resilient padding 50 should be used only for the remaining 10 percent of impact forces. Accordingly, even relatively severe impacts encountered during a football game can be readily accommodated by the three systems referred to.

The crushable material 51 is provided only for extremely severe

circumstances, circumstances which might be severe enough to cause bursting of the compartments 32 and absorbing means 12. The crushable material will give under these severe circumstances and will therefore not be usable thereafter; however, since other damage has occurred; sizing means and absorbing means would have to be replaced in any event.

It will be understood that the energy absorbing means comprising the units 12 are considered to have utility apart from the sizing means and the sizing means likewise have separate utility. Although the respective means cooperate in an ideal fashion as described, the utilization of other complementary arrangements with either of these means is contemplated.

Figure 7 illustrates a contemplated form of the invention wherein a liner 52 serves as a common backing for both the energy absorbing and sizing means. With this arrangement, the sizing means can all be located in position on the liner outside the helmet shell. The energy absorbing means can also be secured to this liner and after all of these elements are in place, the liner can be positioned within the shell.

The provision of the sizing means and the energy absorbing means on a common liner provides many advantages. Assembly is greatly simplified since accurate placement of the elements on the liner is much more easily accomplished than with the placement of the same elements on the interior surface of the shell. Furthermore, the liner can be easily removed in the event of any defects or failure of any of the elements on the liner. A replacement liner can be provided, and there will be no need to discard the helmet shell.

The liner 52 is preferably provided with strap portions 54 adapted to overlap the peripheral edge of the helmet shell. By providing openings in these strap portions in alignment with openings in the helmet shell, the liner can be easily attached and removed.

Figure 9 illustrates one suitable means for securing the liner 52 to the helmet shell. The securing means comprises a fastener 56 formed of a tough resilient material. The fastener includes an enlarged head 58, a reduced diameter shank 60, and an enlarged end 62. A narrow strip 64 is formed

as an extension of the enlarged end. When the holes in the liner strap and shell are in alignment, the fastener can be forced through, and then locked in place when the enlarged end passes the last hole. The strip 64 can be grasped with the fingers to assist in forcing the fastener through the holes. By utilizing a resilient material for the fastener 56, there is a minimum danger of injury if the head should strike a fastener end.

In the arrangement shown in Figure 10, a plate 66 is located over the interior wall of the helmet shell, and an internally threaded sleeve 68 is passed through an opening in the liner 52 and through the helmet shell. A screw 70 is then provided for securing the edge portion 54.

Figure 8 illustrates a preferred form of valve construction. The valve comprises a shank portion 72 which extends through an opening in the helmet shell. The inner end 74 is maintained in spaced apart relationship with the helmet shell by means of a grommet 76 formed of resilient material. In the event an impact force is applied in the area of this valve, it is possible that the wearer's head will actually be moved so close to the surface of the helmet shell that there is a danger of the hard valve material injuring the head. However, before this can occur, the grommet 76 will give thereby allowing the shank 72 of the valve to move outwardly of the helmet shell. The helmet constructions of this invention are, of course, designed so that the wearer's head would never come into contact with a valve; however, the arrangement of Figure 8 is considered highly desirable as a means for preventing injury in the event of failure of other components of the helmet or in the event of highly unusual impact forces.

There has been described an arrangement which provides an extremely satisfactory means for the absorbing of energy and for properly fitting a helmet. The use of liquids or any substantially non-compressible fluid in the energy absorbing means enables the absorption of energy even at extremely high levels whereby the detrimental effects of impacts can be reduced to a minimum. The provision of air or other gas for the sizing means provides a highly effective and easily handled fitting technique. The combination of the energy absorbing means and the sizing means is itself of critical importance particular-

ly since the design of the respective means lends itself to joint installation, for example, on a common backing, and since the highly accurate fitting co-operates with the energy absorbing means in providing a safe helmet.

It will be understood that various changes and modifications may be made in the above described constructions which provide the characteristics of this invention without departing from the spirit thereof particularly as defined in the following claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. In a protective helmet construction adapted to absorb energy when subjected to impact, the improvement comprising a plurality of sizing means positioned on the interior surface of said helmet, said sizing means comprising compartments having a compressible fluid disposed therein, valve means communicating with said compartments for introducing and removing said fluid to thereby permit changing of the size of said compartments whereby the helmet can be worn by different individuals, and energy absorbing means having energy absorbing capabilities completely independent of said compartments and having exposed exterior surfaces for contact with the head of the wearer when impact occurs, said compartments being located at spaced intervals over substantially the entire interior surface of said helmet, and wherein at least some of said energy absorbing means are located in the spaces defined between said compartments.

2. A construction in accordance with Claim 1 wherein at least some of said expandable compartments are interconnected whereby the size of said compartments can be simultaneously adjusted.

3. A construction in accordance with Claim 2 including a common backing for at least some of said compartments whereby the compartments can be installed together within the helmet.

4. A construction in accordance with Claim 3 wherein said compartments are mounted on said common backing.

5. A construction in accordance with Claim 3 wherein said common backing comprises a liner fitting over substantially the entire interior surface of said helmet.

6. A construction in accordance with Claim 1 wherein a bellows type compartment is provided at the crown of the helmet.

7. A construction in accordance with Claim 1 including energy absorbing means located within said compartments, said energy absorbing means being utilized when said impact causes the head of the wearer to compress said compartments

to a substantial degree.

8. A construction in accordance with Claim 5 including means for securing the peripheral edges of said liner to the rim of said helmet.

9. A construction in accordance with Claim 8 wherein said securing means comprise a fastener formed of a plastic material, said fastener having an enlarged head portion, a reduced diameter shank, and an enlarged end portion, an opening defined by said edge of said liner and by said rim of said helmet whereby said enlarged end of said fastener is adapted to be forced through said opening and locked in position opposite said fastener head.

10. A construction in accordance with Claim 1 wherein said valve means include an opening on the exterior surface of the helmet, and including a relatively thick grommet surrounding the shank of said valve adjacent the interior surface of the helmet, said grommet being formed of flexible material whereby the grommet will be compressed if subjected to an impact and whereby the shank of the valve will be forced outwardly.

11. A construction in accordance with Claim 7 wherein said energy absorbing means comprising a first layer of resilient material and a second layer of non-resilient crushable material, said crushable material being located adjacent the interior surface of the helmet.

12. A construction in accordance with Claim 1 wherein at least one of said compartments is located at the front of the helmet for engagement with the forehead of the wearer, and including a sweatband adhesively attached to the exterior surface of the compartment whereby the band can be easily removed and replaced.

13. A construction in accordance with Claim 1 wherein air comprises the fluid disposed within said compartments.

FIG. 1

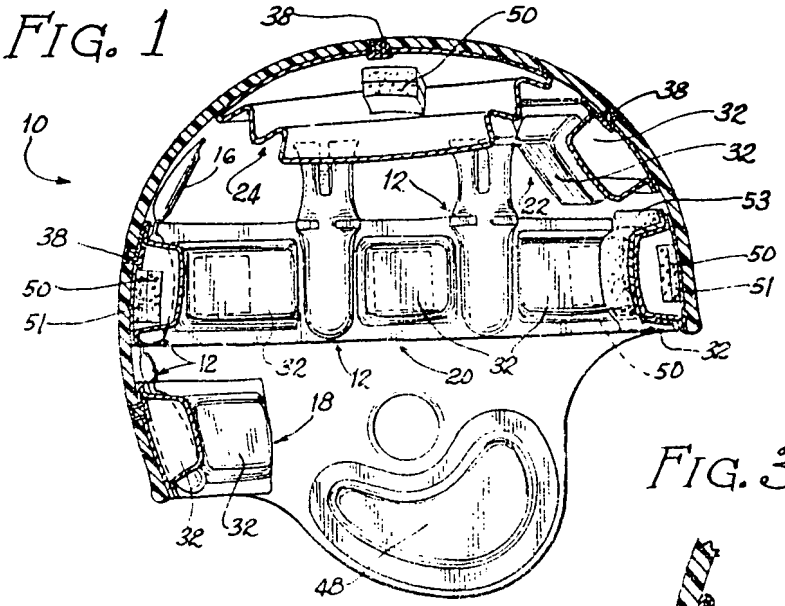


FIG. 2

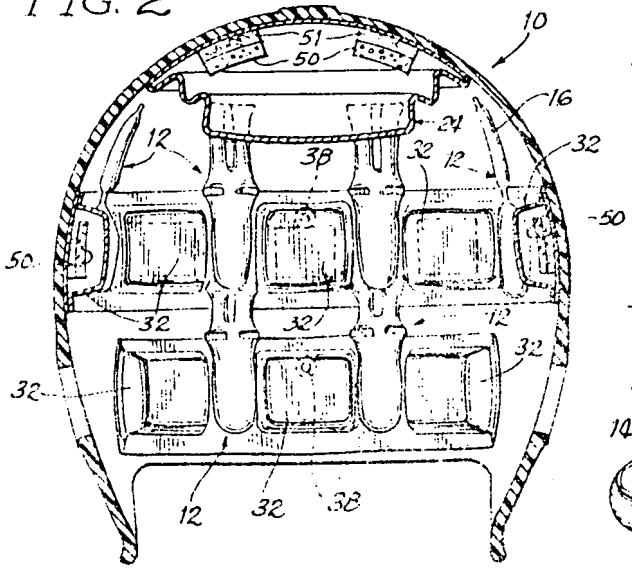


FIG. 3

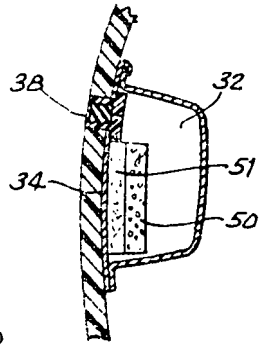


FIG. 4

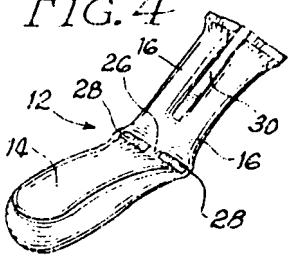


FIG. 5

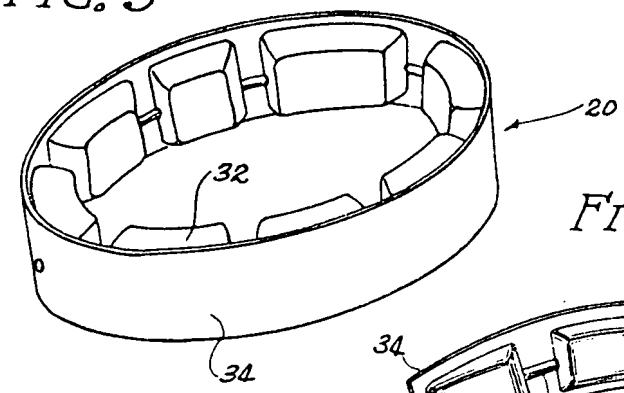


FIG. 6

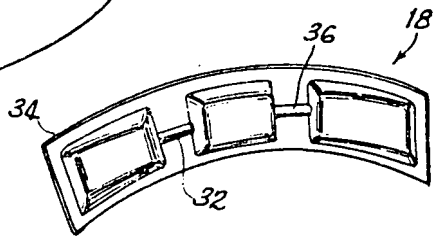
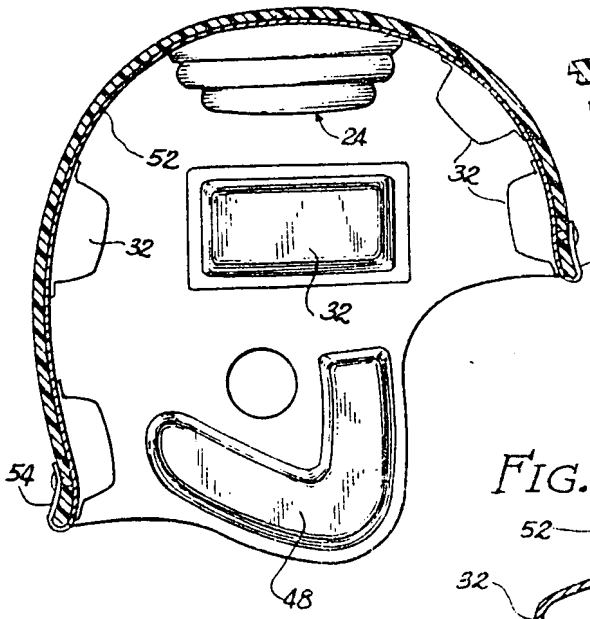


FIG. 7



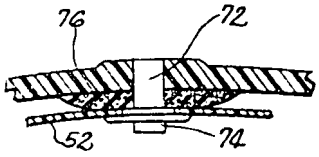


FIG. 8

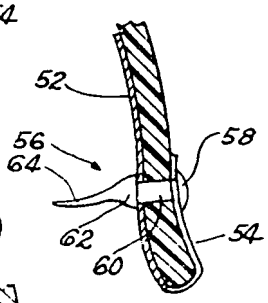


FIG. 9

FIG. 10

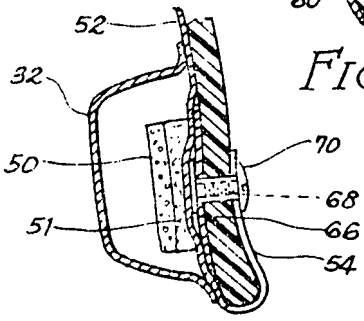


FIG. 11

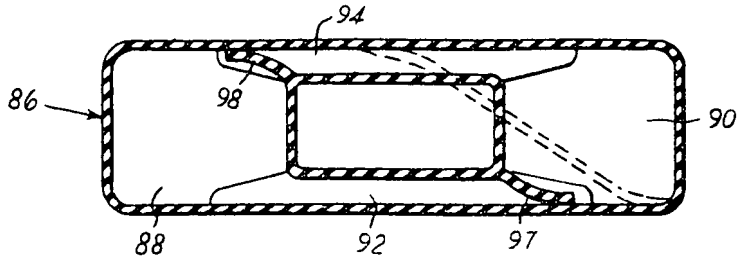


FIG. 12

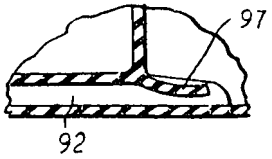


FIG. 13

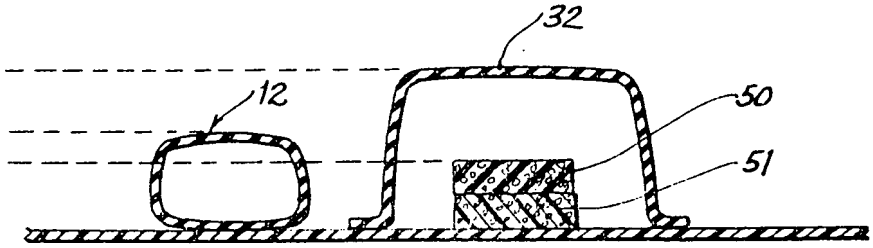


FIG. 14